Construction Methodology

Introduction

This appendix describes the procedures used to develop current estimates of value of construction put in place.

Value-in-place estimates are not published separately for individual series until data for the series are available. Therefore, publication of separate estimates is limited to quarterly data if the series is quarterly, and to annual data if the series is annual; however, projected or interpolated monthly estimates from these series are included in the monthly totals but are not shown separately.

PRIVATE RESIDENTIAL BUILDINGS

New single family

Construction cost of new single family houses started each month is estimated using housing starts and sales data from the U.S. Census Bureau's Survey of Construction (SOC) at https://www.census.gov/construction/nrc/ (for starts) or https://www.census.gov/construction/nrs/ (for sales). The estimated cost of all single units started is then distributed into monthly value put in place by applying fixed patterns of monthly construction progress. The patterns are shown in Table 1 below.

Construction cost is estimated separately for units built to be sold or rented, and units built by the owner or for the owner on contract. In both cases, the total cost is obtained by multiplying the number of units started by an average construction cost per unit. For units built to be sold or rented, the average construction cost is the average sales price at the time of start multiplied by the factor 0.8424. This factor eliminates an estimate of the cost of ''nonconstruction'' items such as raw land, marketing costs, closing costs, and movable appliances. The average construction cost for units built for the owner on contract is the average contract value at time of start increased by the factor 1.102 to eliminate ''nonconstruction'' items and add the value of land development not already accounted for.

Multi-family

A subsample of new residential building projects with two units or more is selected from the SOC. Once a project is selected, monthly construction progress reports are requested from the owner until the project is completed. About 1,500 projects are in the survey each month. This number includes newly selected projects, as well as projects carried over from the previous months. Estimates of value put in place are obtained by multiplying the final weight of each project by the reported value and summing all projects. The final weight can be expressed as follows::

Final weight = (basic weight) x (unit adjustment factor) x (adjustment factor for architectural, engineering, and miscellaneous costs).

a.) Basic weight. The basic weight is the reciprocal of the probability of selection. Since the projects in the Multifamily Survey are a subsample of the SOC sample, the basic weight includes the reciprocal of the sampling rate used in SOC.

b.) Unit adjustment factor. The unit adjustment factor is the ratio of the unbiased estimate obtained from the Census Bureau's Building Permits Survey of the number of Multi-family units authorized in a month to the unbiased estimate from the Multi-family Survey of the number of multi-family units authorized in a month.

c.) Adjustment for architectural, engineering, and miscellaneous costs. The value put in place for the construction of a project includes the total construction cost and fees for architectural and engineering services, and miscellaneous costs. However, monthly reports from sample projects do not include architectural, engineering, and miscellaneous costs. Each month's reported value is inflated to account for these costs so that the sum of the values put in place each month is the total cost of the project. This adjustment factor is defined as the ratio of the total estimated value of the project reported by the owner (construction cost and architectural, engineering, and miscellaneous costs) to the estimated construction cost of the project reported by the owner.

Improvements

Data for this series are obtained by the Census Bureau from household interviews in a representative sample of owner-occupied units. Estimates of expenditures on owner-occupied properties are based on data from the Consumer Expenditure Survey (CE) conducted by the Census Bureau for the Department of Labor's Bureau of Labor Statistics. The CE was designed to provide the Bureau of Labor Statistics with a database for purposes related to the Consumer Price Index. These estimates are not shown separately in the tables of monthly estimates.

Data from owner-occupied units are collected through a rotating panel survey design. The design consists of three panels: one panel is interviewed during the first month of a quarter, another panel during the second month, and a third panel during the last month. Each panel reports on improvements done since the previous interview three months ago; thus, an expenditure may be reported in the interview month, the month before, two months before, or three months before, but after the previous interview. Data collection for expenditures in a particular month will be completed three months later and an estimate based on all of the data will be available approximately five months later. For example, January data collection is complete in April and January estimates are available in June.

The estimates for owner-occupied residential improvements are based on reported data and forecasts. Revised estimates are still based on incomplete reports. Estimates based on complete reports are first used in the May publication for revisions to the previous year. All owner-occupied residential improvements estimates are subject to substantial revisions from the

preliminary estimates due to the necessity of forecasting. Time series techniques with the X-13-ARIMA-SEATS program are used to remove the irregular effects.

PRIVATE NONRESIDENTIAL CONSTRUCTION

The Census Bureau conducts a monthly Construction Progress Reporting Survey for estimating the value of private nonresidential construction in the United States. This survey uses two sources of information for identifying nonresidential building projects:

1. Data from Dodge Data & Analytics (DDA) on projects valued at $75,000 or more in the United States.

2. Projects in a sample of areas not covered by building permit systems or reported by DDA.

Projects from source 1 are stratified by type of construction and construction value. Sixty-six strata are created and each stratum is assigned a specific sampling rate. Of the 66 strata, 16 are certainty strata and have a sampling rate of 1-in-1. Within each of the remaining 50 noncertainty strata, a systematic sample of projects is selected each month continuing from the sample selected from the previous month (see Table 2 below). Projects from source 2 (nonpermit areas) are selected with virtual certainty. Once a project is selected, monthly construction progress reports are requested from the owner until the project is completed. About 6,500 projects are in the survey at any one time.

Estimates of value put in place are obtained by multiplying the final weight of each project by the monthly reported value and summing all projects. The final weight can be expressed as the product of the following:

Final weight=(basic weight) x (outlier adjustment factor) x (adjustment factor for architectural, engineering, and miscellaneous costs) x (frame duplication factor).

a.) Basic weight. The basic weight varies with each source and project.

1. For projects from source 1, the basic weight is the reciprocal of the probability of selecting a project.

2. For projects from source 2, the basic weight is the reciprocal of the probability of selecting a nonpermit segment.

b.) Outlier adjustment factor. This factor reduces the influence on the VIP of an extreme noncertainty observation that reports an extremely large total construction value.

c.) Adjustment factor for architectural, engineering, and miscellaneous costs. This factor is computed in the same manner as in the Multi-family Survey (see above).

d.) Frame duplication factor. This factor adjusts for duplicates in the frames. The factor is 0.99 for private nonresidential projects and is 0.993 for state and local and federal projects.

Imputations are made for projects that have not reported at the time of the monthly tabulation, based on estimated total construction value and month of start of the project. Weighted data are summed over all sample projects by type of construction. The results are increased by 25 percent to account for undercoverage of construction projects not included in the frame. The adjustment for undercoverage results from comparison studies, conducted by the Census Bureau, of DDA reports with building permits for a sample of projects for which permits were issued.

The manufacturing category is further adjusted by benchmarking the tabulated estimates to the latest detailed structures data from the Census Bureau's Annual Capital Expenditures Survey (ACES). The 1992, 1994, 1998, 2003, 2008, 2012, and 2017 levels for industrial buildings are based upon actual ACES data. Estimates for other years are extrapolations from the 1992, 1994, 1998, 2003, 2008, 2012, and 2017 levels.

FARM CONSTRUCTION

Value-in-place estimates for new farm nonresidential construction are extrapolated from the annual U.S. Department of Agriculture (USDA) report, Income and Balance Sheet Statistics. Monthly or quarterly estimates are not available. To estimate monthly values, the trend of the private nonbuilding construction put-in-place estimates is applied to the USDA estimates.

REGULATED INVESTOR-OWNED UTILITIES CONSTRUCTION

Value-in-place estimates for the telephone component of communication construction are based on reports of actual monthly construction progress. For the electric, gas, railroad, oil categories, and the TV cable component of communication, construction put-in-place estimates are based on annual capital expenditure reports compiled by federal regulatory agencies and private organizations.

Pending availability of annual data, monthly estimates for railroads are obtained by distributing Surface Transportation Board quarterly construction expenditures estimates into monthly values. Preliminary monthly estimates for TV cable, gas, and oil construction are based on annual forecasts from SNL Kagan, American Gas Association, and the Federal Energy Regulatory Commission. A portion of the preliminary monthly electric estimates is based on annual forecasts from Edison Electric Institute and Lawrence Berkeley National Laboratory, and quarterly reports from the American Wind Energy Association. The remaining portion of preliminary electric estimates, as well as expenditures made by nonregulated utilities, are gathered in the same method as private nonresidential construction (see above). Monthly estimates are published only for communication and electric; however, estimates for other public utilities are included in the appropriate totals.

PUBLIC CONSTRUCTION

Public construction is composed of two parts: state and local construction and federal construction.

State and Local

The information for creating the sampling frame for the state and local survey is obtained from the same DDA data used for private nonresidential construction (see above).

The projects are stratified by type of construction and value according to the information from DDA. Seventy-two strata are created and a sampling rate is assigned to each stratum. Of the 72 strata, 15 are certainty strata. Within each of the remaining 57 noncertainty strata, a systematic sample of projects is selected each month continuing from the sample selected from the previous month (see Table 3 below). Once a project is selected it remains in the survey until completion of the project, and monthly construction progress reports are requested from the appropriate agency in charge of the project or its designated agent, such as the builder or architect responsible for the project. The average number of projects in the survey at any one time is about 10,500. These include newly selected projects, as well as projects carried over from previous months.

Tabulation of data is the same as for private nonresidential construction. The results are increased by the undercoverage adjustment factors to account for construction projects not reported by DDA. Highway construction is increased by a factor of 1.25, education construction is increased by a factor of 1.20, sewer and water constructions are increased by a factor of 1.24, power construction is increased by a factor of 5.85, housing and hotel constructions are increased by a factor of 2.51, transportation construction is increased by a factor of 1.53, and the others category is increased by a factor of 1.20. These adjustment factors result from a comparison study of projects (for which contracts were awarded and force account work started) provided to us directly from state and local agencies with the list of state and local projects from DDA. For more details on the undercoverage study go to:
https://www.census.gov/construction/c30/pdf/slue.pdf

Federal

Beginning with data for January 2002, estimates for this series are based upon a monthly sample survey of projects. The information for creating the sampling frame is obtained from the same DDA data used for private nonresidential construction (see above).

The projects are stratified by type of construction and value according to the information from DDA. Eighty-four strata are created and a sampling rate is assigned to each stratum. Of the 84 strata, 25 are certainty strata. Within each of the remaining 59 non-certainty strata, a systematic sample of projects is selected each month continuing from the sample selected from the previous month (see Table 4 below). Once a project is selected it remains in the survey until completion of the project, and monthly construction progress reports are requested from the appropriate agency in charge of the project or its designated agent, such as the builder or architect responsible for the

project. The average number of projects in the survey at any one time is about 700. These include newly selected projects, as well as projects carried over from previous months.

Tabulation of data is the same as for private nonresidential and state and local construction. The total monthly federal estimates are further adjusted by benchmarking the tabulated estimates to monthly data, which, with few exceptions, are supplied to the U.S. Census Bureau by each federal agency involved in construction activities. Information is obtained from federal budget documents for a small number of agencies where information cannot be directly supplied. These budget totals are prorated over the fiscal year to derive monthly estimates.

RELEASE AND REVISION SCHEDULE

Preliminary value-in-place (VIP) estimates of the total dollar value of construction work done in the U.S. by private or public sector and type of construction are available in the Construction Spending press release according to the release schedule.

For value-in-place estimates of the total dollar value of construction work done, two months of data are revised along with the release of each month's preliminary estimates. An analysis of the VIP revisions for estimates is updated with the release of each year's preliminary May data. With the release of preliminary May data on the Construction Spending release, seasonally adjusted annual rates for the previous 28 months are also revised to reflect updated seasonal factors. Not seasonally adjusted monthly estimates of total construction spending by owner and type of construction category are also revised to reflect late reports and revised or new estimates from outside data sources.

Preliminary annual estimates are published with the release of January preliminary data for the following year. Annual estimates of value-in-place estimates for the most recent two years are finalized with the release of data for May of the following year. A few estimates that undergo special processing during annual revisions are addressed below.

Periodically construction spending estimates for private manufacturing are benchmarked to the Census Bureau’s Annual Capital Expenditures Survey (ACES) detailed structures data. This was done for data in 1992, 1994, 1998, 2003, 2008, 2012, and 2017. A carry forward factor is applied to estimates in between ACES benchmark years.

Residential Improvements estimates are benchmarked to the annual total estimated using complete monthly data from the Consumer Expenditures Survey (CE) that was not available when the preliminary and subsequent revised monthly estimates were published.

The Federal, Utilities, and Railroad series are benchmarked or derived from outside sources. Some of these sources are unable to provide estimates until a year or two after the reference period. Once the source data is available the series are revised during the following annual revision period.

Disclosure Avoidance

Disclosure is the release of data that reveals information or permits deduction of information about a particular survey unit through the release of either tables or microdata. Disclosure avoidance is the process used to protect each survey unit's identity and data from disclosure. Using disclosure avoidance procedures, the Census Bureau modifies or removes the characteristics that put information at risk of disclosure. Although it may appear that a table shows information about a specific survey unit, the Census Bureau has taken steps to disguise or suppress a unit's data that may be 'at risk' of disclosure while making sure the results are still useful.

The Value of Construction Put in Place Survey uses cell suppression as the primary method of disclosure avoidance.

Cell suppression is a disclosure avoidance technique that protects the confidentiality of individual survey units by withholding cell values from release and replacing the cell value with a symbol, usually a 'D'. If the suppressed cell value were known, it would allow one to estimate an individual survey unit's too closely.

The cells that must be protected are called primary suppressions.

To make sure the cell values of the primary suppressions cannot be closely estimated by using other published cell values, additional cells may also be suppressed. These additional suppressed cells are called complementary suppressions.

The process of suppression does not usually change the higher-level totals. Values for cells that are not suppressed remain unchanged. Before the Census Bureau releases data, computer programs and analysts ensure primary and complementary suppressions have been correctly applied.

The Census Bureau has reviewed the Monthly and Annual Value Put in Place tables for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied (Approval ID: CBDRB-FY21-228).

The Census Bureau has reviewed the Annual Geographic Value Put in Place and Length of Time tables for unauthorized disclosure of confidential information and has approved the disclosure avoidance practices applied. (Approval ID: CBDRB-FY20-ESMD001-01)

For more information on disclosure avoidance practices, see FCSM Statistical Policy Working Paper 22.

Table 1. Monthly Progress Patterns for Private New Single Family Residential Buildings by Month of Start

(Percent of the value of units started monthly)

Month of Activity[1]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	15.8	15.8	15.8	15.8	15.9	16.9	16.9	16.9	16.9	16.9	16.9	15.8
2nd	21.7	23.2	22.5	22.5	22.9	23.8	23.8	23.8	23.8	23.8	21.7	21.7
3rd	21.0	20.1	20.8	20.8	20.8	20.8	20.8	20.8	20.8	18.3	18.3	18.3
4th	16.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0	13.7	13.7	13.7	16.8
5th	10.6	10.3	10.3	10.3	10.3	9.5	9.5	8.8	8.8	8.8	11.7	11.7
6th	6.1	6.1	6.1	6.1	6.1	5.8	5.8	5.1	5.1	7.4	7.6	6.7
7th	3.5	3.5	3.5	3.5	3.5	2.7	2.7	2.7	4.3	4.8	4.3	4.0
8th	2.0	2.0	2.0	2.0	1.5	1.5	1.5	2.5	2.8	3.3	2.8	2.0
9th	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.6	2.0	1.2	1.2	1.2
10th	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
11th	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
12th	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

[1] Month of start is first month of activity.

Table 2. Sampling Rates for Private Nonresidential Construction Projects, by Type of Construction

Value[1] ($1,000)	Lodging	Office	Commer-cial	Health care	Educa-tional	Religious	Amuse-ment and recrea-tion	Transpor-tation	Power	Manufac-turing	NEC
$10,000 or more……	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
$5,000 to $9,999……	1/4	1/3	1/2	1/4	1/4	1/1	1/2	1/1	1/1	1/1	1/2
$2,000 to $4,999……	1/8	1/6	1/4	1/6	1/6	1/2	1/4	1/1	1/2	1/3	1/4
$750 to $1,999…..….	1/8	1/6	1/12	1/8	1/12	1/8	1/8	1/2	1/2	1/3	1/6
$250 to $749……..	1/16	1/25	1/25	1/20	1/16	1/25	1/20	1/4	1/4	1/8	1/12
$75 to $249……	1/40	1/40	1/40	1/35	1/25	1/40	1/40	1/8	1/6	1/25	1/30

[1] Based on the value shown on the McGraw-Hill Construction report.

Note: Projects in cells with sampling rates of 1/1 are selected with virtual certainty.

NEC = Public safety, communication, highway and street, sewage and waste disposal, water supply, and conservation and development.

Table 3. Sampling Rates for State and Local Government Construction Projects, by Type of Construction

Value[1] ($1,000)	Residential	Office	Health care	Educa-tional	Public safety	Amuse-ment and recrea-tion	Transpor-tation	Highway and street	Sewage and waste disposal	Water supply	Conserva-tion and develop-ment	NEC
$10,000 or more….....	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
$5,000 to $9,999……	1/1	1/2	1/2	1/12	1/2	1/2	1/2	1/12	1/4	1/4	1/1	1/2
$2,000 to $4,999……	1/2	1/4	1/4	1/35	1/4	1/4	1/4	1/35	1/8	1/6	1/1	1/4
$750 to $1,999……...	1/4	1/8	1/6	1/60	1/8	1/8	1/8	1/60	1/16	1/16	1/2	1/6
$250 to $749……..…	1/8	1/16	1/12	1/100	1/16	1/16	1/16	1/100	1/25	1/25	1/2	1/25
$75 to $249…….	1/12	1/20	1/20	1/180	1/20	1/20	1/30	1/180	1/60	1/60	1/4	1/60

[1] Based on the value shown on the McGraw-Hill Construction report.

Note: Projects in cells with sampling rates of 1/1 are selected with virtual certainty.

NEC = Lodging, commercial, religious, communication, power, and manufacturing.

Table 4. Sampling Rates for Federal Construction Projects, by Type of Construction

Value[1] ($1,000)	Lodging	Commer-cial	Health care	Educa-tional	Religious	Amuse-ment and recrea-tion	Communi-cation	Power	Highway and street	Sewage and waste disposal	Water supply	Conserva tion and develop-ment	Manufac-turing	NEC
$10,000 or more….	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
$5,000 to $9,999…	1/1	1/1	1/2	1/2	1/1	1/1	1/2	1/2	1/2	1/1	1/2	1/1	1/1	1/1
$2,000 to $4,999…	1/4	1/2	1/4	1/6	1/2	1/1	1/6	1/2	1/6	1/2	1/6	1/1	1/1	1/2
$750 to $1,999…..	1/4	1/4	1/6	1/8	1/8	1/2	1/8	1/4	1/12	1/4	1/12	1/2	1/2	1/4
$250 to $749……...	1/16	1/8	1/12	1/25	1/25	1/4	1/12	1/8	1/25	1/10	1/35	1/2	1/4	1/8
$75 to $249…….	1/40	1/20	1/20	1/40	1/60	1/8	1/30	1/20	1/60	1/20	1/60	1/4	1/8	1/12

[1] Based on the value shown on the McGraw-Hill Construction report.

Note: Projects in cells with sampling rates of 1/1 are selected with virtual certainty.

NEC = Residential, office, public safety, and transportation.